SPIDER FAUNA (ARANEAE) OF ABU GHILAN NATIONAL PARK, NORTH-WESTERN LIBYA

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ABSTRACT

This study was carried out in Abu Ghilan National Park, a protected area and nature reserve, is located on the eastern frontier of the Jabel Nefosa mountain range, in North Western Libya. Spiders were collected using active search and pitfall traps over a period of one year from December 2007 till November 2008. A total of 1872 spiders from 58 genera and 27 families were collected. Some families showed higher diversity in a number of genera (Araneidae, Gnaphosidae, Salticidae and Thomisidae). Spiders showed significant differences among habitat, sampling methods and seasons in regard to abundance, but did not show significant differences regarding diversity. Functional groups distribution was influenced by habitat type. Abu Ghilan National Park has a surprising array of spiders to be a good reserve for conservation.

Keywords: Abu Ghilan, Araneae, Libya, National Park

INTRODUCTION

Biological species are being threatened continuously by human activities, which are leading to the degradation and destruction of habitats (Saini, *et al.*, 2013). Therefore, programs that ensure the protection of habitats of organisms have an important role for biological species conservation. For such programs, it is important to know all living involved organisms. Invertebrates, especially arthropods, have special importance, because of their diversity in terms of number of species, abundance and ecological roles (Foelix, 2011). Spiders are arthropods compromising one of the most important components of the ecosystem where they live, therefore, they are considered as some of the most abundant predators in many agricultural systems (Carter and Rypstra, 1995). Spiders are also potentially useful biological indicators to assess the natural habitat's quality and communities' reaction to disturbance (Maelfait, 1996; Marc and Canard, 1997; Maelfait and Hendrickx, 1998).

There are few studies concerning spiders in Libya; few surveys were conducted by some hobbyists at the beginning of the twentieth century (Elkrwe,

2012). Some specialists conducted surveys and studies related with Libyan spiders; Cambridge recorded 3 genera of spiders in 1872; *Gnaphosa*, *Euophrys* and *Plexippus* (Platnick, 2014). In 1875, Koch recorded one genus; *Trochosa* (Platnick, 2014). Caporiacco recorded 6 Genera; *Agelena*, *Cyclosa*, *Icius*, *Philodromus*, *Theridion*, *Xysticus*, in 1933 (Platnick, 2014). Recently, two studies were performed on the spiders of western Libya: in 2006, 34 families were recorded (Elmareme, 2006); Elkrwe(2012) recorded 51 genera belonging to 25 families. The aim of this study was to investigate the variety of spiders in the Abu Ghilan National Park.

MATERIALS AND METHODS

Study area

Abu Ghilan National Park (32º 15’ 55.99’’ N, 13º 01’ 01.18’’E) (Figure 1) is a protected area and nature reserve established in 1992 to conserve biodiversity. It is located south of Tripoli (~70 km), in the district of Gharyan, on the Eastern end of the Jabel Nefosa mountain range. The area of Abu Ghilan belongs to the North African ecoregion, which constitutes the Mediterranean/Sahara regional transition zone. In fact, it represents an interspace between the arid and semi-arid ecosystems of the Northern part of Libya and the desert.

In the 5000 hectares of its surface, the national park comprises:

1) A mountainous part with rough topography, which ranges from 200 m to about 600 m in altitude.

2) Two main “wadis” located on the western and eastern part, each one with a system of smaller wadi branches around them. A wadi is a narrow valley or ravine, bounded by relatively steep banks, which in the rainy season becomes a watercourse.

3) Lowland with an even surface at the northern foot of the mountainous area.

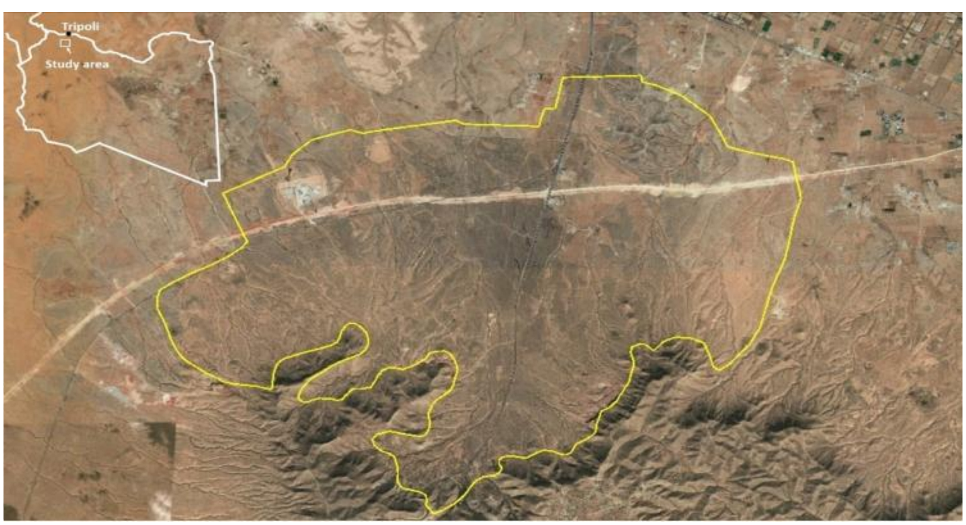

Figure 1: Map of Abu Ghilan National Park in north-western Libya.

The range of geomorphologic features, created by the above-mentioned formations, provide some diverse micro-climatic zones in the area, featuring thus different habitats for plant and animal species.

Sampling

Sampling was conducted over a period of one year from December 2007 till November 2008. Spiders were sampled from two different habitat types (wadis and open land) of the Park. Two sampling techniques (active searching and pitfall trapping) were used at all sites.

Pitfall trapping

Ground-active spiders were collected by pitfall traps (Greenslade, 1964; Uetz and Unzicker, 1976; Sutherland, 1996). 15 Plastic cups were used as pitfall traps in each habitat. Each trap consisted of two cone-shaped plastic (polyethylene) cups 10 cm wide at the mouth and 12 cm deep, one inside the other, buried to their rims. The inner cup of each trap was filled to a third of its volume with propylene glycol (Coddington, 2005). The traps were laid on a line transect every 10 m. The contents of the traps were collected monthly and placed into a sample bottle containing 70% ethanol and later spiders were separated from the other invertebrates.

Active searching

Spiders were collected on ground, under rocks, in the pits or in leaf litter. The most sampled spiders were collected by forceps; some other tools were used such as insect nets and mouth suction samplers. Unfortunately, the sampled spiders that were collected from both habitats were pooled together.

Identification

The spiders were identified to genus level using different keys using dissected microscope (Barrion and Litsinger, 1995; Dippenaar-Schoeman and Jocqué, 1997).

Diversity indices

The diversity, richness, and evenness indices of spider communities were calculated using web site: http://lbsite.zxq.net/programs/diversity.html. As well as Sorensen's coefficient of similarity (Ss) was calculated (Howaege, 1998):

$$Ss = \frac{2a}{2a+b+c}$$

where "a" is the shared species between sample 1 and 2, "b" is the unique species in sample 2 and "c" is the unique species in sample 1.

Statistical analyses

The numbers of collected spiders were tested for normality by the one-Sample Kolmogorov - Smirnov Z test (K-S). Thereafter, the data, which was not normally distributed, were compared using non-parametric tests, considering $P \leq 0.05$ as significant. All statistical analyses were carried out on SPSS 20.0 statistical software (SPSS, 2011).

RESULTS

A total of 1872 individuals from 58 genera and 27 families were sampled in Abu Ghilan National Park during the study period (Table 1).

Families and genera

The most abundant family was Salticidae with 338 individuals (18.1%) followed by Gnaphosidae (211 individuals, 11.3%), and Theridiidae (200 individuals, 10.7%); Ammoxenidae was the least abundant one (one individual, 0.05%). Salticidae was the most diverse family (10 genera) followed by Thomisidae (5 genera) then Araneidae and Theridiidae (4 genera), Agelenidae, Eresidae, Lycosidae and Philodromidae (3 genera); the rest were represented by only one genus (Table 1). 11 families were sampled by both techniques (active searching and pitfall trap), while 16 families were sampled by one method, either by active searching (10 families) or pitfall trapping (6 families). 13 families were sampled in all seasons, while four families were sampled in three season, three families were sampled in two seasons, and seven families were sampled only in one season (Table 1). 50% of plant wanderer spiders were collected by both methods, almost all ground wanderers were sampled using pitfall traps, and all web-builders were collected by active searching. 51 genera were sampled using active search and 34 genera using pitfall trapping, this difference is not significant (χ^2, P= 0.07). Most families represented by one genus, the rest were represented by 3-10 genera (Table 1). The number of genera among seasons were not different significantly (χ^2, P=0.19).

Seasons

Summer was the most diverse season, 23 families and 53 genera were collected, followed by autumn (19 families, 46 genera), spring (19 families, 42 genera), then winter (16 families, 33 genera). In terms of abundance, also summer was the most abundant season (855 individuals), followed by autumn (535 individuals), spring (315 individuals) and winter (137 individuals). This confirmed by Shannon-Weiner Index (Table 2). All seasons showed high values of evennes. The seasons showed approximate values of Sorensen's coefficient of similarity in sampled genera, which varied between 0.67 and 0.90 (Table 3). The differences of richness among seasons were not significant (χ^2, P= 0.14), while those of abundance were significant (χ^2, $P<0.001$).

Table 1: Total numbers of spider families' genera and individuals sampled from Abu Ghilan National Park

Functional group	Family	Total Genera	Sampling method		Season			
			Active search	Pitfall	Winter	Spring	Summer	Autumn
GW	Agelenidae	3 (18)	2(7)	1 (11)	1 (4)	1 (5)	3 (7)	2(2)
	Desidae	1 (34)		1 (34)	1 (22)	1 (3)	1 (1)	1(8)
	Dysderidae	1 (68)	1 (22)	1 (46)	1 (23)	1 (24)	1 (14)	1(7)
	Ammoxenidae	1 (1)		1 (1)	1 (1)			
	Gnaphosidae	5 (211)	5 (92)	3 (119)	3 (15)	5 (30)	5 (74)	4(92)
	Lycosidae	3 (160)	3 (107)	3 (53)	3 (13)	3 (48)	3 (62)	3(37)
	Microstigmatidae	1 (2)		1 (2)		1 (2)		
	Oecobiidae	1 (3)		1 (3)	1 (1)			1(2)
	Palpimanidae	1 (19)	1 (4)	1 (15)		1 (3)	1 (6)	1(10)
	Scytodidae	1 (10)		1 (10)			1 (4)	1(6)
	Sicaridae	1 (41)	1 (23)	1 (18)	1 (1)	1 (1)	1 (19)	1(20)
	Titanoecidae	1 (7)	1 (7)				1 (7)	
PW	Clubionidae	1 (17)	1 (17)				1 (17)	
	Filastidae	1 (9)	1 (9)				1 (9)	
	Oxyopidae	1 (6)		1 (6)	1 (1)	1 (5)		
	Philodromidae	3 (78)	3 (72)	2 (6)	3 (10)	2 (17)	3 (31)	3(20)
	Salticidae	10 (338)	10 (326)	7 (12)	4 (19)	8 (44)	10 (175)	8(100)
	Thomisidae	5 (79)	5 (47)	4 (32)	4 (16)	4 (25)	4 (22)	5(16)
WB	Araneidae	4 (137)	4 (137)		3 (14)	4 (19)	4 (68)	4(36)
	Eresidae	3 (27)	3 (27)			1 (2)	3 (19)	3(6)
	Hersiliidae	1 (8)	1 (8)				1 (8)	
	Linyphiidae	1 (93)	1 (93)		1 (15)	1 (13)	1 (42)	1(23)
	Pholcidae	1 (157)	1 (157)			1 (27)	1 (10)	1(29)
	Segestriidae	1 (7)	1 (7)				1 (7)	
	Theridiidae	4 (200)	4 (193)	4 (7)	4 (9)	4 (40)	4 (97)	4(54)
	Uloboridae	1 (57)	1 (57)		1 (3)	1 (4)	1 (27)	1(23)
	Zodariidae	1 (85)	1 (22)	1 (63)		1 (3)	1 (38)	1(44)
TOTAL	27 (1872)	58 (1872)	51 (1435)	34 (438)	33 (137)	42 (315)	53 (855)	46 (535)

Table 2: Diversity indices of spiders of Abu Ghilan National Park.

Index	overall	Sampling method		Habitat		Season			
		Active search	Pitfall Trap	Open areass	Wadis	Winter	Spring	Summer	Autumn
Genus Richness	58	51	34	24	31	32	42	53	46
Shannon-Weiner Index	3.71	3.59	2.83	2.63	2.74	3.02	3.37	3.61	3.49
Evenness	0.91	0.91	0.8	0.83	0.8	0.87	0.9	0.91	0.91

Table 4: Total numbers of spider according to functional groups sampled from Abu Ghilan National Park

Functional group	Number of genera	Sampling method		Habitat		Season			
		Active search	Pitfall Trap	Open areass	Wadis	Winter	Spring	Summer	Autumn
GW	20 (574)	14 (262)	15 (312)	12 (61	15 (251)	12 (80)	14 (116)	17 (194)	15 (184)
PW	21 (527)	20 (471)	14 (56)	8 (24)	13 (32)	11 (46)	15 (91)	19 (254)	16 (136)
WB	17 (771)	17 (702)	5 (70)	4 (7)	3 (63)	9 (41)	13 (108)	17 (407)	15 (215)
TOTAL	27 (1872)	51 (1435)	34 (438)	24 (92)	31 (346)	33 (137)	42 (315)	53 (855)	46 (535)

GW- ground wanderers, PW- plant wanderers and WB- web builders.

Numbers in parentheses represent the total number of individuals collected.

Table 3: Sorensen's coefficient of similarity index for spiders of Abu Ghilan National Park

Season	Winter	Spring	Summer
Spring	0.80		
Summer	0.67	0.81	
Autumn	0.80	0.90	0.86

Habitat

Regarding the spiders which sampled using pitfall traps, we could separate those that were collected from open areas and wadis, unlike the collected spiders by active searching. Ten families were not sampled (Araneidae, Clubionidae, Eresidae, Filastidae, Hersiliidae, Linyphiidae, Pholcidae, Segestriidae, Titanoecidae and Uloboridae). Most families, which were collected by pitfall trapping distributed in both types of habitat. No significant differences among habitats were recorded respecting number of genera (χ^2, P= 0.35), but, spiders more abundant wadis than in open lands (χ^2 P<0.001). Three families were represented in wadi habitat but not in open land habitat (Ammoxenidae, Oecobiidae and Scytodidae). All families that sampled in both habitat types showed the same situation of diversity i.e. families were represented by one genus in one habitat also were represented in the other. Although wadis habitat appeared more diverse, no obvious differences in respect of the diversity indices (Table 2). The value of Sorensen's coefficient of similarity showed high similarity between both types of habitat (0.91).

Functional groups

The collected spiders were divided into three functional groups: the plant wanderers (PW), ground wanderers (GW) and the web-builders (WB).

Web builders were the most abundant group (771 individuals), comprising 41% of all spiders sampled. Ground wanderers comprised 31% (574 individuals) and plant wanderers, 28% (527 individuals) (Table 4). There were significant differences among numbers of functional groups, but no significant difference between ground wanderers and plant wanderers (χ^2, P=0.16). Abundance of functional groups differed significantly among each sampling method, as well as, among each habitat (χ^2, P<0.00001). The genera richness ranged between 17 (Web builders) and 21 (plant wanderers), there were no significant differences among functional groups in terms of numbers of genera (χ^2, P=0.8).

Abundance of ground wanderers was significantly affected by habitat type (χ^2, P<0.001) and sampling method (χ^2, P= 0.04). Also, web-builders abundance was affected by both habitat type (χ^2, P<0.001) and sampling method (χ^2, P<0.001). In the case of plant wanderers their abundance affected only by sampling method

(χ^2, P<0.001), but not by habitat (χ^2, P= 29). Regarding richness (number of genera), only, web-builders were affected by sampling method (χ^2 P=0.01). All functional groups were significantly different in regard of abundance (χ^2, P<0.01), unlike the richness (χ^2, P>0.1).

DISCUSSION

Families

Some families showed high relative diversity and abundance, i.e Gnaphosidae, Salticidae, Theridiidae and Thomisidae. Desert spider families: Gnaphosidae, Lycosidae, Salticidae, and Thomisidae adopted to the arid environments, which can be considered as limiting factors for the spider fauna in desert ecosystems (Cloudsley and Thompson, 1983). They have some behavioural adaptations (i.e burrowing) and physiological adaptations such as metabolic compensation to high temperature (Abdelmoniem, *et al.*, 2003).

16 families were sampled by one method, which can be attributed to behaviour of spiders. Web-builder spiders tend to stay on their webs, therefore, they are rarely collected by pitfall traps. As stated in literatures, pitfall traps may not reflect the true abundance of arthropods, rather the activity density (Topping and Sunderland, 1992). Ground wanderers can be easily sampled by pitfall traps since they are active hunters; their mimic behaviour constraints active search sampling. Plant wanderer spiders were collected by both methods. Active searching includes beating. Factors effects includes seasonality, spatial heterogeneity, competition, predation, habitat type, environmental stability and productivity (Rosenzweig, 1995; Whitmore, *et al.*, 2002).

Seasons

Seasons differed significantly in spider abundance, these differences are correlated to the climatic changes through different seasons of the year. Spiders respond to changes in temperature through the year (Daiqin, *et al.*, 1996), and can, like other animals, change altitude to maintain their preferred range of climatic conditions (Evans, 1997).

Some families were collected in a single season, all of them were represented by one genus. Probably, these genera can be found at that time. Actually, this is interesting and needs further investigations.

Habitat

Wadis habitat showed more abundance than open land habitat which can be attributed to the habitat features, especially plant cover, and availability of resources for spiders (McIver, *et al.* 1992, Abdelmoniem, *et al.* 2003). Wadis habitat offers higher amounts of litter, used as shelters offering good hunting chance for spiders. Stippich (1989) reported, experimentally, that spider densities increased when they used more litter.

No significant differences were found among habitats in genera richness, this could be explained by that different habitats may include similar microenvironmental conditions with similar resources availability.

Abu Ghilan National Park includes, relatively, poor vegetation structure. Vegetation play an important role for abundance and diversity of web building and plant wandering spiders (Whitmore, *et al.*, 2002). It is important for feeding, building retreats or for web building. Therefore vegetation structure has an impact on spider diversity. There were more ground wanderers than plant wanderers and web builders.

Local habitat features and human activities determine local diversity and have an important impact in managed or semi-natural habitats (Caley and Schulter, 1997; Clough, *et al.,* 2005). Spiders are extremely sensitive to changes in the habitat structure i.e. disturbance increases the spider species richness decreases (Downie, *et al.,* 1999; New, 1999; Whitmore, *et al.,* 2002).

Whitmore, et al. (2002) reported 38 spider families recorded from savanna reserve (Makalali Private Game Reserve, South Africa), he stated, accordingly, savanna is an essential biome to conserve. In our case the high diversity of spiders encourages to establish earnest conservation programs in the park especially wadi habitats.

Indeed, little articles have been published regarding Libyan spiders, mostly were done by hobbyists, some other scientific work were achieved (Nashnosh, *et al.*, 1992; Elmareme, 2006; Elkrwe, 2012; Platnick, 2014). Elmareme (2006) collected spiders belonging to 25 families from the area between Farwa and Azawya. Those families also collected by Elkrwe (2012) who reported 25 families and 51 genera from Tripoli area between Tajoura and El-maya. Some families that they reported were not collected in our study (Sparassidae and Tetragnathidae). On the other hand, we collected spiders belong to families: Ammoxenidae, Microstigmatidae, Oecobiidae and Scytodidae, those families not reported in their studies. Some of those families were recorded for the first time in Libya (Bourass *et al.,* in prep)

Our study added to spider fauna knowledge in Libya. Spider in Abu Ghilan National park need more attention in terms of taxonomy and identification.

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